

Analysis of Data Re-Uploading Quantum Classifiers Across Multiple QKD Protocols

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Abstract

The data re-uploading classifier of Pérez-Salinas *et al.* (2020) demonstrated that a single qubit, repeatedly re-encoded with classical input across sequential processing layers, can act as a universal classifier on geometric pattern-recognition benchmarks. This work evaluates whether the same architecture-with no modification to its encoding scheme, layer structure, or fidelity-based cost functions-generalizes to quantum key distribution (QKD) round data. For each of five QKD protocols (BB84, E91, BBM92, SARG04, and Six-State), we construct round records from each protocol’s basis and bit choices, map them to feature vectors, and train independent re-uploading classifiers to predict the round’s bit value from its encoded features. Circuits are trained and evaluated across 1-9 qubits and 3-4 layers, using both the fidelity and weighted fidelity cost functions from the original formulation, with CZ-entangled layer variants for multi-qubit configurations. Classification fidelity on QKD round data is comparable to that reported on the original geometric benchmarks, and fidelity scaling with qubit count and layer depth varies systematically across protocols, tracking differences in basis-set size and reliance on entanglement. These results indicate that the representational universality of the data re-uploading classifier extends to structured quantum-communication round data without architectural modification, and that its scaling behavior offers a quantum-native lens for comparing protocol-level structural complexity across QKD schemes on near-term devices.

Index Terms

quantum machine learning, quantum classifier, quantum key distribution, BB84, E91, BBM92, SARG04, Six-State QKD protocol